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RURAL ELECTRIFICATION IN THE
CHINESE PEOPLE'S REPUBLIC

-Communist China-

By B. Bannikov

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FOREWORD

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RURAL ELECTRIFICATION IN THE CHINESE PEOPLE'S REPUBLIC

[Following is the translation of an article by B. Bannikov in Tekhnika v Sel'skom Khozyaystve, No 2, Moscow, 1960, pages 88-92.]

Extensive work associated with the electrification of the country is being conducted in the Chinese People's Republic. Rural electrification is also beginning to develop. This is favored by the intensive nature of agriculture, its rapid development, the presence of mostly large socialist farms (people's communes and state farms) in the country, the extensive possibilities of utilizing electrical energy for mechanized irrigation, the possibilities of using numerous local rivers and canals for the construction of rural hydroelectric power stations, and the easily mined rich deposits of coal for use by thermal electric plants. The seacoast which abounds in bays, coastal rivers and canals, permits the development of a program of construction of rural electric power plants that would utilize the energy furnished by the tides. The dense population of the important agricultural regions of the country is also conducive to the development of rural electric power networks.

Under conditions such as these it is possible and feasible to construct various electric power installations necessary for the provision of rural areas with electricity, including electric power plants of rationally selected power ratings. A gradual transition to the construction of local rural power systems and their unification with the developing nationwide power networks will be conducted.

The construction of large hydraulic and thermal electric power plants and of power lines, the expansion of existing and the creation of new power networks is being conducted since the advent of the people's government in China. In 1949 the total capacity of all the electric power stations in the country amounted to only 1.85 million kilowatts, and their total power output did not exceed 4.31 billion kilowatt-hours, whereas in 1959 the capacity of the power plants was raised to 8.8 billion kilowatts and the production of electric power amounted to 41.5 billion kilowatt-hours. Therefore, after 10 years of the people's government, the capacity of the country's electric

power plants increased by 4.7 times and the annual production of electrical energy increased by 9.6 times.

The rapidly growing production of electric power in the KNR (Kitayskaya Narodnaya Respublika -- Chinese People's Republic) creates the conditions necessary for a successful resolution of all the problems associated with the organization of a system for the provision of agricultural regions with electric power. If the fact that the agricultural population of the country comprises approximately 85% of the total population is taken into consideration, it becomes quite clear why the electrification of agricultural regions of this large country is of such importance.

A policy of "walking on two feet" has been adopted in the electrification of the country. This means that it is planned to construct both modern large electric power plants and small power plants by utilizing various local sources of energy. The Chinese consider that a policy of "walking on both feet" permits the electrification of the country "from top to bottom", i.e. to build large electric power plants with modern equipment at government and "from the bottom to the top", i.e. to build small electric power plants with the simplest equipment, erected by the people's methods involving the resources of the population.

Power transmission lines are still poorly developed in the country; a lack of metal and cement is felt. This limits the possibilities for merging agricultural consumers with the existing power lines and is detrimental to development and the construction of reasonably large rural power plants including hydroelectric power plants.

The All-China Conference, which took place in Tientsin in August of 1958, after taking into consideration the existing situation, recommended that the agricultural cooperatives construct small hydroelectric plants with power capacities of up to 50 kilowatts. Such plants require neither specialized equipment nor the critical material and may be constructed by any agricultural cooperative. Small rural thermal electric power plants are also being constructed in certain regions of the country and agricultural cooperatives are being connected to the existing power transmission lines.

Therefore the electrification of agriculture in China in its first stage of development is characterized by the construction of small electric power plants, the transmission of power over short distances and the utilization of electricity in a limited number of agricultural processes. This stage will be passed as soon as the upsurge of the entire national economy and the development of electrical power engineering will permit the satisfaction of the inherent needs of a rural electrification for equipment, apparatus and materials.

New possibilities for the mechanization and electrifica-

tion of agricultural production have come about since the co-operativization of individual farms (1956). The population of the agricultural regions undertook the construction of small electric power plants that utilize local sources of energy at its own expense. An abrupt turning point occurred in 1958 when the movement for the provision of the country with power assumed the nature of a mass movement. The workers of both cities and villages of China began to utilize all locally available sources of energy: the hydraulic energy of the local rivers and canals, coal, gas, wind energy and that of the tides. Various old and new engines were put into widespread use for that purpose including portable engines, automobile engines and others. As a result many villages, small cities, enterprises and the suburbs of large cities became supplied with electric power generated by their own small electric power plants. In the northeast of China, for example, the construction of small electric power plants by means available to the people through the application of conventional methods provided 300,000 kilowatts of additional power, including 130,000 kilowatts in the cities of Port Arthur and Talien.

The primary position in the provision of agricultural regions with electricity in both volume and power rating is occupied by the transformer substations of the non-rural electric power stations. Of secondary importance are the rural thermal electric plants. In 1958 there were 2,112 such plants in the country. In the third place are the rural hydroelectric power plants.

Preliminary calculations made at the Tientsin Conference stipulate a development of the program for the electrification of agriculture in a manner that would provide electricity to five new rural areas in each province over a period of three years, from 1959 to 1961.

Electric power networks of 35, 10, 6.6 and 3.3 kilovolts are the most common ones in the KNR. But even these networks are still rather scarce. In the Yunnan Province, which contains a population of 19.1 million, there are only 148.7 kilometers of rural electric networks, most of which (100.2 km) consist of 6.6 kilovolt power transmission lines. The overall length of the rural networks in the Shensi Province, containing a population of 18.13 million, is 284 km. The Honan Province with a population of 48.67 million has only 305 km. of rural power transmission lines.

Wooden supports are used in the construction of rural power transmission lines, as well as metal wires; both pole and open transformer substations are constructed. The basic equipment, as well as all of the construction and maintenance material is produced by Chinese industry.

At the present time electrical energy is primarily used in agriculture for the cleaning and processing of grain, grist

and for the preparation of fodder and for various auxiliary workshop operations. With the development of electrification more electrical energy will be used for mechanized irrigation. It is estimated that 99% of the country's arable land requires irrigation. The total irrigated area consisted of one billion mou in 1958, i.e. 66.7 million hectares (1 mou = 1/15 hectare).

Three-fifths of this area is irrigated by gravity flow, and 400 million mou require mechanical pumping of water to an average altitude of seven to eight meters. At the present time the water for irrigating 300 million mou is pumped by hand or with the aid of draft animals. Only 100 million mou are irrigated with water supplied by electrically or mechanically operated pumps. The irrigation of fields with water from wells is at the present time widely practiced in China. Of the 11 million wells, some 10.5 million wells (97%) are equipped with the simplest water tanks operated by hand or draft animals.

The development of an electrified mechanical system of irrigation will also be conducive to a more rapid agricultural reclamation of mountain and mountain-hill regions and to the realization of a policy adopted in China, that of "making fruit orchards out of mountains".

Electric power may be widely used in the cultivation of arable land with plows operated by rope traction. This problem is being thoroughly studied by the scientific-research organizations of the KNR.

The utilization of electric power is associated with the agricultural trends in the various regions of the KNR. In the northern and the northeastern provinces electricity is most often used for thrashing, the processing of grain crops and grist and at animal breeding farms. In the southern and the southwestern provinces electric power is needed for the drying of tea, fruit, tobacco and for operating the butter churns. The central provinces require electric power for the processing of silk, cotton and rice. The various regions contain rural handicraft industries that manufacture china, glazed earthenware, ceramic and bamboo products, and areas where cement substitutes, pulp and chemical fertilizers are produced. All these enterprises as well as the workshops where auxiliary work is accomplished, require electricity in varying degrees.

The producers' combines in agricultural regions are usually created close to small hydroelectric power plants. In daytime the mechanical energy of the hydroelectric installation is used for different types of agricultural and auxiliary production, while during the hours of darkness the electrical energy is utilized mainly for illumination.

It is necessary to note that the people's communes that were created in the KNR acquired the jurisdiction over the entire handicraft industry in the rural areas of the country. Their requirement for electric power therefore increased con-

siderably.

At the present time all of the perspective plans stipulate a wider use of electric power in agriculture. It is stipulated that by the end of 1962 electric power will be used in basic varieties of stationary agricultural work and in workshops as well as in the rural handicraft industry in the Hungtung rural area (Shensi Province), with a population of 310,000.

The rural hydroelectric plants, whose capacity during 1958 increased by 131.5 thousand kilowatts, occupy a place of special importance in the electrification of agriculture in the KNR. Due to the simplicity of such installations, the possibility of utilizing locally available building materials and the uncomplicated equipment involved (including wooden turbines) in addition to the speed of construction and the negligible capital investment that is required, the rural hydroelectric plants became popular among the broad peasant masses of the KNR.

The small rural hydroelectric plants are constructed in the KNR on a principle "make small capital investments -- obtain considerable effect". The table cites figures that characterize the development of the construction of rural hydroelectric plants in China from 1949 to 1958.

	1949	1950	1951	1952	1953	1954
Number of rural hydroelectric plants	57	68	83	98	105	114
Overall capacity in kilowatts	5,330	6,248	7,804	8,137	8,321	8,445
In % to 1949	100	117	146	152	156	158
Average capacity of a single plant (in kilowatts)	91	92	89	83	79	74

	1955	1956	1957	1958		
Number of rural hydroelectric plants	127	240	544	5,228		
Overall capacity in kilowatts	8,900	11,860	20,324	151,826		
In % to 1949	166	221	378	2,880		
Average capacity of a single plant (in kilowatts)	70	60	37	28		

As evident from the table, a big leap ahead in the construction of rural hydroelectric plants took place in 1958 when their overall capacity increased 28.8 times in comparison with 1949 and 7.5 times by comparison with 1957.

The first stage of rural electrification in the Soviet Union was also characterized by the construction of small hydroelectric plants.

By way of comparison we cite data on the construction of rural hydroelectric plants in the USSR over a period of several years that yields a picture of the tendencies that develop in this type of construction. In 1950 there were only 4,860 rural hydroelectric plants in our country, in 1955 -- 5,640, in 1956 -- 5,680, in 1957 -- 5,740 and in 1958 -- 5,800. The overall capacity over those years amounted to 243, 410, 430, 460 and 500 thousand kilowatts. It is evident from the cited figures that the increase in the power capacity of rural hydroelectric plants in the KNR amounted to 750% in 1958 by comparison with 1957 and in the Soviet Union it amounted to a little more than 8%. In 1950 the capacity of such plants was 39 times less than the ones in the USSR, in 1955 -- 46 times less, in 1956 -- 40 times less, in 1957 -- 22 times less and in 1958 only 3.3 times less.

The fact that the average capacity of the rural hydroelectric plants in the KNR dropped from 92 to 28 kilowatts between 1950 and 1958 is evident. The average capacity of such plants in the USSR increased from 50 to 86 kilowatts over the same period of time. In China this circumstance characterizes the early stage of electrification of agricultural regions and the mass construction of small rural hydroelectric plants. In the USSR the construction of small hydroelectric plants ceased and the construction of the more economical larger plants was carried out. In the future we will construct only regional and inter-regional rural hydroelectric and thermal electric plants.

It should be stressed that due to extensive development of the power systems and power transmission lines the hydroelectric and thermal electric plants in the Soviet Union do not have the same significance that this type of installation has at the present time in the KNR. The capacity of all of the rural hydroelectric plants in the USSR comprise only a negligible portion of the overall capacity of the power installations that are used in the country's agriculture. This is explained by the fact that the small rural hydroelectric plants as a rule have low technical-economic indices. At the same time the larger hydroelectric plants with capacities of from 1,000 to 10,000 kilowatts are quite profitable under rural conditions.

The power supply requirements in both volume and quality have increased with the creation of the people's communes in the KNR. This is taken into consideration in all of the perspective computations.

At the present time the drafting and construction of larger hydroelectric plants in China is gradually developing. Most frequently they are not designated for exclusively agricultural use but have a mixed designation. These plants considerably exceed the small hydroelectric plants in their technical-economic indices.

At the given stage, however, when the country is experiencing a lack of electrical power, it is considered in the KNR that the construction of small rural hydroelectric plants is fully justified.

In October of 1958 the first All-China Conference on the Utilization of the Energy Provided by Tides took place in Shanghai. This conference included the participation of representatives from scientific research, project research, construction and other organizations. According to the material on this conference, the tidal energy of the entire Chinese seacoast is estimated at 275 billion kilowatt hours and the overall potential capacity of the tides is 110 million kilowatts.

According to computations made by Chinese specialists, it is possible to construct 80 tidal electric power plants with individual capacities of from 20,000 to several million kilowatts in eight of the coastal provinces as well as on Taiwan. The capacity of a tidal electric power plant on the Hangchow Bay (Chekiang Province) is estimated at 7.7 million kilowatts. Large tidal electric power plants with capacities of over one million kilowatts each may be constructed on the Sanmen Bay (Chekiang Province) as well as on the Fuchinwang Bay and Shinghuanwang Bay (Fukien Province), as well as on the bays of other coastal provinces.

It is also possible to construct a large number of small tidal plants and to utilize them in agriculture.

According to preliminary calculations, the capacity of all the large and small tidal electric power plants that are planned for construction will amount to 35.8 million kilowatts. The possible practical value of ocean tides is estimated at 87 billion kilowatt-hours, which is some two and a half times greater than the combined production of electric power by all of the electric power generating plants of the KNR during 1959.

At the present time small tidal electric power plants are under construction on the smaller tributaries of rivers that flow into the ocean, in areas where the tides are perceptible. The electric power produced in these cases is utilized for the illumination in the populated areas and for the electrification of agricultural projects such as the cleaning and grinding of grain.

Taliang, a tidal electric power plant, has been constructed in the Shinte rural district (Kwangtung Province) with a capacity of 144 kilowatts; it contains three wooden propeller turbines 48 kilowatts each.

Timei, a new tidal electric power plant with a starting capacity of 200 kilowatts, has been constructed in 1959 on the Formosa Straits close to the city of Hsiao-Men (Fukien Province) on the bay of Hsinling. It is possible to increase that capacity.

Small tidal electric power plants in China are a peculiar type of laboratory which is used to study the operating conditions of hydroelectric generators that utilize the periodic energy of the changing tides.

There are no specially established central or provincial organizations in China occupied exclusively with the electrification of agriculture. Various ministries are cooperativized for that purpose as well as the different state and public organizations. The Ministry of Water Resources and Power Supply supervises the general perspective planning of the small and large electric power supply projects. The Ministry of Agriculture resolves problems associated with the construction of rural hydroelectric plants. The Ministry of Machine Building develops rational types of rural hydroturbines. The Ministry of Trade supplies the people's communes with equipment and material.

Both the departments of water resources and power supply and the departments of agriculture in the provinces engage in the planning and construction of rural hydroelectric plants. The power administrations supervise the construction of substations and of the power transmission lines. The republican and provincial planning organs review and adopt provincial plans and regulate the amount of basic equipment designated for rural electrification.

The project institutes as well as provincial project organizations participate in the development of typical and concrete drafts of projected hydroelectric power plants, thermal electric plants, transformer substations and village power transmission lines. The Peking Project Institute of Water Resources and Power Supply, for example, prior to 1959, published three typical plans for rural hydroelectric plants with capacities of 100, 1,000 and 10,000 kilowatts. The Peking "Thermal Electric Project Board" compiled a series of drafts for typical small thermal electric power plants. The project institutes of the Ministry of Water Resources and Power Supply, located in many of the provinces, also develop plans for small electric power plants for rural electrification. In addition to that, the various provincial departments of water resources and power supply also include project groups which concern themselves with the problems of developing irrigation and the construction of small hydroelectric plants.

The construction of all the small rural electric power plants in the KNR was conducted by the agricultural cooperatives, and since the end of 1958, by the people's communes. According to data furnished by a team of the Ministry of Water Resources and Power Supply, which surveyed individual provinces in 1958,

the small rural hydroelectric plants were basically constructed at the expense of the cooperatives and partially by subsidies, and hydroelectric plants with capacities of over 300 kilowatts were constructed exclusively at the expense of the local budget. The construction of rural hydroelectric plants with capacities of up to 60 kilowatts in the Shansi Province was delegated to the rural districts and the construction of the more powerful plants was delegated to the various districts. The conference on the construction of average capacity plants which took place in the city of Chengchou in 1958 adopted a resolution to construct a single hydroelectric plant with a capacity of 500 kilowatts in every district of the country and to construct a hydroelectric plant with capacities of from 5 to 10,000 kilowatts in each national area.

The people's communes themselves operate the small rural electric power stations and short power transmission lines. The operating personnel are selected from among the former builders and usually undergo a short course.

The training of specialists of the higher and secondary ratings is conducted in certain institutes and technical schools. A department of electrification of agriculture was established at the Peking University in 1959. Short courses are sometimes organized in provinces and national areas as the need arises for the training of qualified workers -- brigade leaders, foremen and electricians.

The basic equipment necessary for the electrification of agriculture is manufactured by the Harbin, Shanghai, Chungchin and other plants. The demand for such material considerably exceeds the possibilities available in the country. Therefore the handicraft production of equipment necessary for rural electrification at small enterprises and workshops is widely developed in the country. These handicraft enterprises manufacture wooden turbines, switchboards, small motors and insulators. The large electric power plants use their own workshops to manufacture generators and water turbines for the small electric power plants. The utilization of electric power in agriculture is studied by the scientific research institute of mechanization of the Academy of Agricultural Sciences KNR. Certain academic institutes and planning organizations fulfill individual work in addition to providing technical aid in the electrification of agricultural regions. The Taiyuan Politechnical Institute (Shansi Province) for instance, compiled a plan for the electrification of the Hungtun rural area, the Harbin Politechnical Institute participates in projects associated with the electrification of rural regions in the northeastern provinces. Certain problems of rural electrification are also being studied by the Institute of Power Supply of the Academy of Sciences KNR. The Project Institute of the Ministry of Machine Building is engaged in determining the most rational types of water turbines

for the rural hydroelectric plants.

It is proposed to conduct the electrification of agriculture in the KNR in stages gradually accelerating the tempo. It is planned that the first stage, or as it is called here, the preliminary electrification of agriculture, will be completed within a three year period, i.e. by the end of the Second Five Year Plan (1962). According to computations made by the Chinese specialists, it is estimated that with a norm of from 100-150 watts of power per household (excluding local industry and other consumers) all the rural electric power plants and substations must have a capacity of 18-24 million kilowatts by 1962. It is also proposed to electrify 60%-80% of the processing involved in basic agricultural production -- thrashing, cleaning grain, hulling rice, grinding, processing oil crops, etc.

All these considerations and computations are of course of a preliminary nature and will be revised more than once. But the cited figures do indicate the great power capacity required even for a preliminary electrification of the agriculture of this large country.

Perspective plans for the electrification of individual agricultural regions and areas in the various provinces are being compiled in China since 1958. Plans for the electrification of agriculture for all rural districts, national areas and provinces will be compiled gradually. The development of a plan for the electrification of the socialist agriculture of all of China is awaiting its turn. This will permit the creation of a scientific and technical foundation for the perspective development of rural electrification over the next 10-15 years.